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coniugis attonitus fatis urbisque ruina
quos generos vocem ego aut quae nunc me ad foedera
flectam?

From this simple exposition of Vergil's treatment of the story of Latinus it is evident that in plot and in characterization the tale meets the chief requirements of a tragedy. The action is in or near the city of Latinus, save in the scene which takes place at Ardea. The most obvious weakness of the proposed drama is in the essential nature of Latinus. Sheer futility is tragic, but so negative a quality lacks dramatic force. The wavering purpose is Euripidean, but the conventional tragic hero is hardly so lacking in self-assertion.

That a five-act drama does thus emerge from the larger story of the Trojan conquest of Latium does not necessarily imply that the poet was influenced by some existing tragedy on this theme or that he was even aware of the striking resemblances between his narrative and a drama. We may rather conclude that, in addition to a familiarity with classical drama, the poet himself had to an unusual degree that keen sense of the importance of dramatic form which we know to have characterized Greek and Roman writers in general, even prose writers of orations and of philosophical dialogues[16].

VASSAR COLLEGE CATHARINE SAUNDERS

REVIEW

Antike Technik. Sieben Vorträge von Hermann Diels. Zweite, Erweiterte Auflage, mit 78 Abbildungen, 18 Tafeln, und 1 Titelbild. Leipzig und Berlin: B. G. Teubner (1920).

The author, whose life has passed the limit prescribed by the psalmist, has published several valuable works on Greek writers and Hellenic affairs, and comes well equipped for the task he has undertaken in the present instance.

The book is not intended as a general treatise, but is a collection of searching investigations of selected topics (an analogous plan is followed in some of these special investigations, some particular point being elaborated). Constant reference is made to the works of others, very many of which are of recent date. Of course, for obvious reasons, most of the authorities referred to are German, but foreign works are not ignored as such; we find French authorities cited often, and sometimes English and American, not to mention others.

In his researches the author employs all available means of avoiding erroneous conclusions. When he is dealing with matters that lie outside of his field, he calls specialists to his aid. Especially in the preparation of models of ancient mechanisms was this care important. The results of his investigations, thus interpreted and executed by experts, are such that visitors to European collections need to be warned against the danger of being misled by totally erroneous models or 'restorations'. For instance, we learn that Napoleon appointed a philologian and a general to study the texts and construct models of the ancient 'artillery'.

> Leider arbeiteten beide, die sehr eigensinnig waren, nicht gut zusammen. So sind die grossen Geschützmodelle, die noch heute im Museum St. Germain aufgestellt sind, wenig mehr als moderne Phantasiekonstruktionen.

Another instance is the model of a water clock in the Deutsches Museum in Munich, which is "äusserlich glänzend, aber innerlich völlig verfehlt".

One feature of the work deserves special commendation: it contains abundance of illustrations, many of which are photogravures. Without these the book would be like a geometry without diagrams.

The work proper consists of an address before the Marburg Philological Assembly, four lectures at the Salzburg Hochschule, an address before the Archaeological Society (in Berlin), March 4, 1913, and, finally, the substance of an address before the Prussian Academy of Sciences, July 19, 1917.

The Preface to the first edition is dated Easter, 1914, that to the second, Easter, 1919. In the first is stated the object of the work, to do something toward bringing together the antagonistic parties consisting of those who have contempt for things ancient and those who devote themselves to the study of antiquity, and to aid even the latter to a better understanding of the progress made by the ancients in things material. The author emphasizes the necessity of cooperation between the idealism of scholars and the realism of scientists and mechanicians.

An attempt to give a practically useful epitome of the work would be idle. Only so much will be said on the treatment of each topic as is necessary to convey some idea of the character of the book.

I. *Wissenschaft und Technik bei den Griechen*

Passing over prehistoric matters, the author begins with Thales and discusses concisely the theories and the achievements of Anaximander, Cleostratus, Harpalus, Mandrocles, Pythagoras, Eupalinus, Heraclitus, Hippodamus, Polycletus, etc. The tunnel made by Eupalinus to convey water through Mt. Athos to the city of Samas is illustrated by means of a map, and by the diagram of Hero showing how the calculations were made for cutting a tunnel from both ends. There is reason to believe that Hero may have had this very tunnel in mind.

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[16] For a recent treatment of this characteristic see Dramatic Interpretation in the Teaching of the Classics, by Gonzalez Lodge, Teachers College Record 21. 217-237 (May, 1920), reprinted in THE CLASSICAL WEEKLY 14. 73.77, 81-85. For Vergil, reference may be made to an editorial, The Aeneid as a Tragedy: Dido, A Latin Tragedy, THE CLASSICAL WEEKLY 8.169-170, especially to the bibliography of this theme given on page 170, and to H. O. Ryder, A Miniature Drama: Aeneid 1.338-368, THE CLASSICAL WEEKLY 11. 175-176.

The far-reaching influence of the School of Miletus is discussed, and the 'artillery' of the Greeks is described and its history investigated, especially its employment by Dionysius the Elder. Then follows a similar treatment of the School of Pythagoras in particular, considerable space being given to medicine and surgery. One illustration in the course of this discussion is a photogravure of a bit of papyrus from which alone was learned the name, Diades, of the great mechanical engineer who served under Alexander at the siege and capture of Tyre and other cities. There is here also a sensible discussion of the causes that led to the contempt of the ancients for craftsmen and artificers of all sorts, among whom they classed physicians, surgeons, engineers, and the like. To this contempt there was one exception, Archimedes. The reasons for his becoming famous are discussed, and an account is given of his mathematical and mechanical achievements. Here such men as Archimedes are commended, and the necessity of theory and practice, pure science and applied science going hand in hand, is elaborated.

II. *Antike Türen und Schlösser*

Beginning with Homer, the author devotes fifteen pages to descriptions and illustrations of ancient, especially Greek, doors and locks. Many of the illustrations are taken from ancient representations. The ingenuity displayed in devising locks and keys is in no degree inferior to that of the present day.

III. *Dampfmachine, Automat, Taxameter*

This lecture is devoted almost entirely to Hero of Alexandria. Those who are familiar with Wilamowitz-Moellendorff's Griechisches Lesebuch are acquainted with most of the topics here treated, but it may be worth while to enumerate them.

(1) Hero's Ball, from which water was forced out by compressed air—a principle already employed in the construction of the fire-engine by Ctesibius, and virtually in use at the present day.

(2) Hero's Steam Sphere, caused to rotate by the retroaction of escaping steam (three illustrations).

(3) Automata. Here considerable space is given to an account of the performance of a play by automata in a theater—the ancient 'moving pictures'.

(4) The Hodometer. The description given by Hero is reproduced in full. The wheel of a vehicle sets in motion a series of cog wheels, like clock-work, which record the rotations of the carefully measured wheel, and so give the distance passed over. The instrument resembles our gas-meters. Vitruvius describes an instrument (similar to the hodometer) which indicated the distance in a different way, and adds that it may be used in navigation.

(5) Holy Water automaton: the first slot-machine. A coin dropped through a hole opens a valve by means of a lever and lets the water flow for a brief moment. It seems not to be known whether the inventor of the modern slot-machine got his idea from Hero or not.

IV. *Antike Telegraphie*

This lecture begins with an account of secret communications between persons at a distance from each other. The first instance recorded in Greek literature was the famous folded tablet of Iliad 6.169. The *skytale* is discussed and explained. In the course of time additional means of communication were devised. Aeneas Tacticus enumerates sixteen different methods, one of which is illustrated by a diagram. But he does not mention the carrier pigeons, though it is well established that they were already in use in the fifth century B. C. Fire-signalling is discussed, and a map shows the line of signal stations from Troy to Mycenae, according to Aeschylus in the Agamemnon[1]. Of course the details here are treated as fictitious, but it is contended that some such line of stations may have existed. Such signalling required a prearrangement between sender and receiver of messages. Means of overcoming this difficulty are mentioned and discussed, especially the system described by Polybius 10.45. Then follows a brief sketch of telegraphy down to what is now understood by 'telegraphy' and 'signalling', closing with mention of the employment of intense lights even by day, as was done by the Germans in 1914-1918. At the end of that period improvements were made which have been kept secret.

V. *Die Antike Artillerie*

Our knowledge of the ancient machines of warfare is derived partly from historians, but chiefly from writers on the subject, especially Philo, of Byzantium, and Hero. The results of earlier attempts to reconstruct, from these sources, such machines, even including the attempt instituted by Napoleon III, were not entirely satisfactory. But, recently, General E. A. Schramm, aided by the late Dr. Rudolf Schneider, as linguist, is believed to have achieved practically perfect restorations. As the ancient machines were made chiefly of wood, very few remains of them have survived, but many projectiles (balls) and some arrow-points have been found.

The large machines ('artillery') were formerly believed to have been invented by the Jews, since this is expressly stated in II Chronicles 26.15; but it is now believed that the author of this book lived about 500 years after the events he narrates, and that he committed an anachronism.

The bow and arrow have been in practically universal use from time immemorial. From the bow arose the cross-bow, certainly in use in the Roman period, and, no doubt, earlier in Greece. The failure of the historians to mention it is probably due to the fact that it was used in hunting rather than in warfare. The Greek writers begin with the γαστραφέτης (a word not found in Liddell and Scott), which was an enlargement of the crossbow, with resulting modifications. In Diels's book it is fully described, with illustrations. Here our author inserts a description, with illustration, of a war-engine derived from the sling–the μονάγκων, or *onager*, as the Romans called it.

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[1] Reference may be made to a paper, 32 pages long, by Augustus C. Merriam (formerly Professor at Columbia University), entitled Telegraphing Among the Ancients. This was published as No. I of Classical Series III of the papers of the Archaeological Institute of America (Cambridge, John Wilson and Sons, 1890). On pages 24-32, Professor Merriam discussed the "Problem of the Line of Beacon-Fires", Aeschylus, Agamemnon 281-316.
C. K.

The catapults proper are now discussed. It is not possible here to make a useful abstract of this very interesting part of the work. Suffice it to say that the subject is treated with clearness and thoroughness from every point of view, though an artillerist might wish that the author had collected all the data bearing on caliber and range. These are carefully considered, but there seems to be no mention of the ταλαντιαῖος πετροβόλος (or λιθοβόλος), a '60-pounder', with an effective range of only about 600 feet, according to Philo, who says it was the most powerful of the siege-pieces.

The latter part of the lecture brings the history down to and including the invention of gunpowder and its application—the invention of the cannon.

> Diesen bedeutenden Fortschritt verdanken wir weder den Arabern, . . . noch den Chinesen, sondern den Deutschen, die bei Byzantinern wie Italienern als die Erfinder der neuen 'barbarischen' Technik angesehen wurden.

In this part of the lecture there is an interesting discussion of the steam cannon ascribed to Archimedes, with the illustrations made by Leonardo da Vinci. The author believes that the story of this invention originated among the Arabians, who are known to have made other forgeries under the name of Archimedes.

The lecture closes with an able justification of the destructive inventions of the Germans. A footnote states that this justification was written just as it stands before the Great War broke out.

VI. *Antike Chemie*

The origin of the name of this science is minutely investigated. The author believes that it originated from χῦμα, 'Metallguss', so that *chymie* would be more accurate than *chemie* (some of us can remember when it was often called *chymistry* even by scientists). Then follows a most laborious and painstaking investigation of the alchemistic literature in ancient times, when an important part was played by a large work forged under the name of Democritus. The conclusion is that the mystic character of ancient chemistry, that is, what we call alchemy, originated from a Hellenic source, and specifically in the Pythagorizing circles of Egypt.

The earliest extant records of what may be called chemistry are now taken up. These are two papyri found in an Egyptian grave in 1828; they belong to the third century after Christ. The writing is beautiful, the spelling very bad. One of these papyri lay in Leyden, virtually buried, until 1885, when it was published; the other, after some roaming, found its way to Upsala, where it was published in 1913. The first reveals the secrets of the Egyptian falsification of metals and of purple dyeing; the other treats of silver, purple, pearls, and precious stones, chiefly with a view to imitation. The account given here of the contents of these papyri is exceedingly entertaining, whether one be interested in chemistry and antiquities or not. This account is followed by an investigation of the sources from which the papyri sprung. These papyri and similar documents were strictly secret (the users being bound to secrecy by a solemn oath), not only from the general public, but even from those whom we should call experts. An investigation of this mystery leads to the conclusion that the men possessing and transmitting these secrets were the Egyptian priests.

The lecture concludes with the transition from this art of fraud and deception to the science of chemistry, which may be dated from Lavoisier at the close of the eighteenth century.

VII. *Die Antike Uhr*

This article (enlarged address) of 78 pages constitutes one-third of the entire work. It may safely be pronounced the most trustworthy and complete treatment of the subject that we have.

First the sun-clocks (dials or sun-dials, as we call them) are treated, then the water-clocks (*clepsydrae*). The measuring of time perhaps more than anything else requires a combination of scientific knowledge and mechanical invention. The subject here treated consequently is specially adapted to enabling us to judge of the intellect and the mechanical achievements of the ancients.

A brief account is given of the measurement of the year by the sun and the determination of the month by the moon and of the difficulties growing out of the fact that these units thus measured are not commensurable.

The subdivisions of the day (the day itself being obviously fixed also by the sun) were, in the earlier historical period, very vague among the masses of the people, but scientific men in Egypt, Babylon, and China had been for two thousand years making observations on the sun, and the sun-dial was introduced from Babylon by Anaximander. The shadow of the gnomon by its varying length indicated the time of year and determined the seasons and the whole year, and furnished means of ascertaining the obliquity of the ecliptic, which was observed by Anaximander.

In classical literature there is repeated mention of estimating the time of day by the length of one's own shadow. This, of course, depended on the latitude and the time of year, and there is extant a work of Palladius (fourth century A. D.) containing hour-tables for measuring the hours in this way.

The sun-clock, which measured hours as well as seasons, seems to have established itself in Greece during the fifth and fourth centuries B. C., and must have been used by such men as Oenopides and Meton. Dionysius the Elder, of Syracuse, had a large one constructed. Eudoxus of Cnidos (408-335) invented an improvement on the then existing sun-clocks. He spent several years in Athens in association with Aristotle and other pupils of Plato. It is noteworthy that in the famous mosaic of Torre Annunziata (a picture of which forms the frontispiece of this book), representing Plato teaching in the Academia, a sun-clock is seen at the top of a column.

Our sun-dials are very easy to make for a given latitude, whereas the ancients were confronted by difficulties arising from the fact that daytime, that is, from sunrise till sunset, was divided into twelve equal parts for each day, so that these parts ('hours') varied in length from day to day, the average length being that of the equinoctial hour. Hence the scientifically constructed clocks of the ancients indicated the time of year and the hour-lengths for that date—a process requiring the use of curves, which at first were probably empiric, but later were made on geometrical principles resulting sometimes in conic sections.

Not only were stationary clocks constructed, but portable clocks were devised for any latitude, and for travel generally. Several men, otherwise known for genius, took part in the improvement of these clocks.

We have ancient descriptions of sun-clocks, and these clocks are found on many walls and in excavations. The work before us carefully classifies them according to plans of construction (of which there is a considerable number), describes them minutely, and furnishes about twenty-five illustrations, some of them photogravures.

For cloudy weather and night time and for indoor use, as in court-rooms, some other means of measuring time were necessary. Hence originated, not later than the fifth century B. C., the *clepsydra*, or water-clock, which worked on the same principle as the sand-glass or hour-glass, which was in general use a century ago, and still lingers in some places, that is, the time is measured by the flow of water through a small opening, usually a tube.

The name *clepsydra*, 'water-thief' (humorously bestowed, as is often done in such cases), was transferred to the water-clock from a kitchen utensil, erroneously treated in some of our books as a species of the water-clock. It was a vessel entirely closed, except that it had many very small perforations in the bottom, like a colander, and a hole in the handle small enough to be covered by the thumb. The handle of some was a long slender vertical neck open at the top, that of others an arch attached at both ends, with a hole at the summit. When pressed down into water it soon filled, excluding large impurities, and then with the air shut off by the thumb it could be carried away without appreciable loss of water. Its theory is said to have been investigated by Anaxagoras.

The treatment of the water-clock is like that of the sun-clock in thoroughness and abundance of illustrations. Only a few striking facts, some of them not known until a recent date, can here be mentioned.

Unlike the sun-clock, the water-clock is capable of putting machinery into operation. The first and perhaps most interesting instance of this was the alarm clock constructed under the direction of Plato, which sounded a note, or, as we should say, blew a whistle, when the proper time arrived, to arouse and call to work the pupils in the Academia. This clock is reported to have suggested to Ctesibius, the great genius, the invention of the water-organ, and, we may infer, also, the invention of the fire-engine. He was easily the greatest physicist and mechanician of that period; some of his inventions have survived to the present time. He also devised a method of adapting a water-clock to the varying lengths of hours. An ingenious attempt is here made to restore the construction of such a clock with the aid of the rather vague description given by Vitruvius (9. 8. 6). In this connection is described a clock with a dial and hour-hand, mentioned by Vitruvius. To be traced to inventions of Ctesibius are the hour-striking clock ascribed to Archimedes and various clocks that presented at the ends of hours automata comparable to those of modern clocks. Some of them are described, with illustrations, and through analogous clocks of the Middle Ages we are brought down to the famous Strasburg clock, the handiwork of Germans.

UNIVERSITY, VIRGINIA MILTON W. HUMPHREYS

THE CLASSICAL MEETING AT CAMBRIDGE, ENGLAND[1]

To a member of the American Philological Association, and of the Regional Classical Associations in America, points of contrast and resemblances between the meeting of The Classical Association of England, at Cambridge, in August last, and classical meetings in America were of interest. The British Classical Association is not a counterpart either of the American Philological Association, or of such a regional Association as The Classical Association of the Atlantic States; rather it combines features of both. Unlike the American Philological Association it is not made up merely of those who teach in Colleges and Universities or are interested in advanced philology. It does, indeed, bring together such persons; most of the distinguished classical scholars are present at the meetings. On the other hand, it draws a large number from among the teachers in the Secondary Schools and from friends of the Classics who have no connection whatever with education. On the whole, then, it resembles our various Regional Classical Associations more than it does the American Philological Association. The foremost English classical scholars feel that here is a good chance to compare notes with the workers in the Secondary Schools and with all who are interested in the advancement of classical studies. One quality of the British papers at such a meeting especially impresses the American observer: their attention to form, to style. Their papers sparkle with wit, with finished phrase. Unless the listener is interested as well as instructed, readers of papers are not satisfied. The results, at the hands of past masters of the art, are striking. 'No dull moments' seems to be the slogan of their meetings. At the meetings of the American Philological Association our

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[1] Professor Chase's account of this meeting arrived after Professor Hirst's report of it had been sent to the printer (THE CLASSICAL WEEKLY 15. 7-8). The following extracts from Professor Chase's account are sure to interest many.

C. K.